Additional Practice Problems for Thermochemistry

(1) Calculate the heat of reaction: $4HNO_3\ (l) \rightarrow 4NO_2\ (g) + 2H_2O\ (l) + O_2\ (g)$

+ 257.6 kJ/mol

Steps:

$-2\ (H_2\ (g) + N_2\ (g) + 3O_2\ (g) \rightarrow 2HNO_3\ (l))$ $(\Delta H = -348.2\ kJ/mol) - 2$

$2\ (N_2\ (g) + 2O_2\ (g) \rightarrow 2NO_2\ (g))$ $(\Delta H = 66.4\ kJ/mol)\ 2$

$-1\ (2H_2O\ (l) \rightarrow 2H_2\ (g) + O_2\ (g))$ $(\Delta H = 571.6\ kJ/mol) -1$

$4HNO_3(l) \rightarrow 2H_2(g) + 2N_2(g) + 6O_2(g)$ $\Delta H = 696.4\ kJ/mol$

$2N_2(g) + 4O_2(g) \rightarrow 4NO_2(g)$ $\Delta H = 132.8\ kJ/mol$

$2H_2(g) + O_2(g) \rightarrow 2H_2O(l)$ $\Delta H = -571.6\ kJ/mol$

$4HNO_3(l) \rightarrow 4NO_2(g) + 2H_2O(l) + O_2(g)$ $\Delta H = 257.6\ kJ/mol$ endothermic

(2) Calculate the heat of reaction using the Bond Energy.

$4HI\ (g) + O_2\ (g) \rightarrow 2H_2O\ (l) + 2I_2\ (g)$ + 468 kJ/mol

Lewis Structures:

HI	O_2	H_2O	I_2
H–I:	O=O	H–O–H	I–I

ΔH = broken − formed

= 1690 − 2158

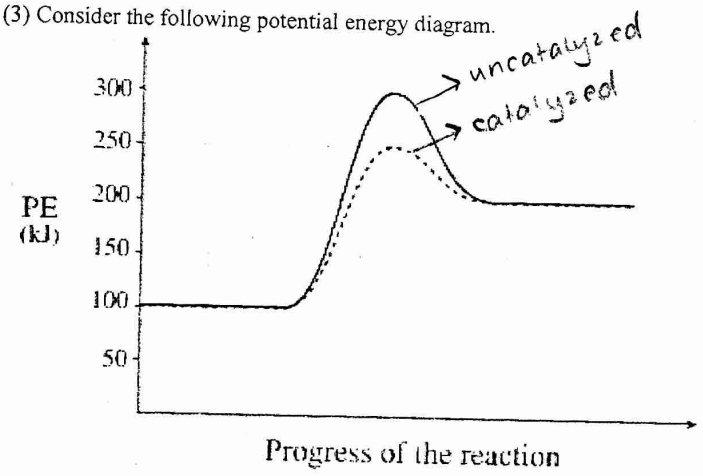
= −468 kJ/mol exothermic

4(H-I) + O=O 4(H-O) + 2(I-I)

4(298) + 498 4(464) + 2(151)

= 1690 kJ/mol = 2158 kJ/mol

(3) Consider the following potential energy diagram.



(a) Label the catalyzed pathway and the uncatalyzed pathway.

(b) What is the name of the highest energy point in a reaction?
activated complex

(c) What quantity is given the symbol ΔH? enthalpy, heat of reaction

(d) What quantity is given the symbol E_a?
activation energy

(e) What is ΔH for the forward, uncatalyzed reaction?
+100 kJ

(f) What is ΔH for the forward, catalyzed reaction?
+100 kJ

(g) What is ΔH for the reverse, uncatalyzed reaction?
−100 kJ

(h) What is ΔH for the reverse, catalyzed reaction?
−100 kJ

(i) Is the forward reaction endothermic or exothermic?
endothermic

(j) Is the reverse reaction endothermic or exothermic?
exothermic

(k) What is E_a for the forward, uncatalyzed reaction?
+200 kJ

(l) What is E_a for the forward, catalyzed reaction?
+150 kJ

(m) What is E_a for the reverse, uncatalyzed reaction?
+100 kJ

(n) What is E_a for the reverse, catalyzed reaction?
+50 kJ